The documentation and process conversion measures necessary to comply with this revision shall be completed by 15 December 1993

INCH-POUND

MIL-S-19500/323D
15 September 1993
SUPERSEDING
MIL-S-19500/323C
9 July 1987

MILITARY SPECIFICATION
SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING
TYPES 2N3250A, 2N3251A, JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP silicon switching transistors. Three levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See 3.3.

1.3 Maximum ratings.

P_T 1/ T_A = +25°C	P_T 2/ T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{op} and T_{STG}	$R_{\theta JA}$
W	W	V dc	V dc	V dc	mA dc	°C	°C/W
0.36	1.2	60	60	5.0	200	-65 to +200	485.4

1/ Derate linearly 2.06 mW/°C above T_A = +25°C.

2/ Derate linearly 6.90 mW/°C above T_C = +25°C.

1.4 Primary electrical characteristics.

	h_{FE1}		h_{FE3} 1/		h_{FE4} 1/		$\|h_{fe}\|$	
Limits	V_{CE} = 1.0 V dc I_C = 0.1 mA dc		V_{CE} = 1.0 V dc I_C = 10 mA dc		V_{CE} = 1.0 V dc I_C = 50 mA dc		f = 100 MHz V_{CE} = 20 V dc I_C = 10 mA dc	
	Min	Max	Min	Max	Min	Max	Min	Max
2N3250A	40		50	150	15		2.5	9.0
2N3251A	80		100	300	30		3.0	9.0

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ECT, 1507 Wilmington Pike, Dayton, OH 45444-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Limits	$r_b'C_c$ V_{CE} = 20 V dc I_C = 10 mA dc f = 31.8 MHz	$V_{CE(SAT)1}$ I_C = 10 mA dc I_B = 1.0 mA dc	C_{obo} V_{CB} = 10 V dc I_E = 0 100 kHz ≤ f ≤ 1 MHz	t_{on} I_C = 10 mA dc I_B = 1.0 mA dc	t_{off} I_C = 10 mA dc I_B = 1.0 mA dc		N_F V_{CE} = 5 V dc I_C = .1 mA dc .1 mA dc R_g = 1kΩ f = 100 Hz
					2N3250A	2N3251A	
		V dc	pF	ns	ns	ns	dB
Min	5						
Max	250	0.25	6	70	250	300	6

1/ Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

I_{BEX} - - - Base cutoff current (dc) with specified circuit between the collector and emitter.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, appendix F, figure 9.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

4.3 Screening (JANS, JANTX, and JANTXV levels). Screening shall be in accordance with table II of MIL-S-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	h_{FE3}, I_{CBO}	Not applicable
11	I_{CBO}; h_{FE3}; ΔI_{CBO} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE3} = 25 percent change from initial value.	I_{CBO} and h_{FE3}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CBO} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE3} = 25 percent change from initial value.	Subgroup 2 of table I herein; ΔI_{CBO} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE3} = 25 percent of change from initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in 4.5 of MIL-STD-750; V_{CB} = 25 V dc (10 V dc for JANS); P_T = 360 mW.

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500 and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in IVa (JANS) and table IVb (JANTX and JANTXV) of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps and footnotes of table II herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B4	1037	V_{CB} = 10 V dc; P_T = 360 mW at T_A = +25°C ±3°C; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	V_{CB} = 10 V dc; T_A = +125°C ±25°C for 96 hours, P_T = 360 mW at T_A = +100°C or adjusted as required according to the chosen T_A to give an average T_J = +275°C.
B6	3131	See 4.5.3.

4.4.2.2 Group B inspection, table IVb (JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B3	1027	V_{CB} ≥ 10 V dc; P_T = 360 mW at T_A = +30°C ±5°C. No heat sink or forced-air cooling on the devices shall be permitted.
B5	3131	See 4.5.3.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps and footnotes of table II herein.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	V_{CB} ≥ 10 V dc, P_T = 360 mW at T_A = +30°C ±5°C. No heat sink or forced-air cooling on device shall be permitted.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Collector - base time constant. This parameter may be determined by applying an rf signal voltage of 1.0 volt (rms) across the collector-base terminals, and measuring the ac voltage drop (V_{eb}) with a high impedance rf voltmeter across the emitter-base terminals.

With f = 31.8 MHz used for the 1.0 V signal, the following computation applies; $r_b'C_c(ps) = 5 \times V_{eb}$ (millivolts), see figure 3.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage collector - base	3001	Bias condition D; I_C = 10 µA dc	$V_{(BR)CBO}$	60		V dc
Breakdown voltage emitter - base	3026	Bias condition D; I_E = 10 µA dc	$V_{(BR)EBO}$	5		V dc
Breakdown voltage collector - emitter	3011	Bias condition D; I_C = 10 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	60		V dc
Collector - base cutoff current	3036	Bias condition D; V_{CB} = 40 V dc	I_{CBO}		20	nA dc
Collector - emitter cutoff current	3041	Bias condition A; V_{CE} = 40 V dc; V_{BE} = 3.0 V dc	I_{CEX1}		20	nA dc
Base cutoff current	3041	Bias condition A; V_{CE} = 40 V dc; V_{BE} = 3.0 V dc	I_{BEX}		50	nA dc
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 0.1 mA dc	h_{FE1}			
2N3250A				40		
2N3251A				80		
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 1.0 mA dc	h_{FE2}			
2N3250A				45		
2N3251A				90		
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE3}			
2N3250A				50	150	
2N3251A				100	300	
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 50 mA dc; pulsed (see 4.5.1)	h_{FE4}			
2N3250A				15		
2N3251A				30		
Current gain linearity		$\frac{\lvert h_{FE3} - h_{FE1} \rvert}{h_{FE3}} \times 100$	h_{FE}			
2N3250A					40	percent
2N3251A					30	percent

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued.						
Collector - emitter saturated voltage	3071	I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{CE(sat)1}$		0.25	V dc
Collector - emitter saturated voltage	3071	I_C = 50 mA dc; I_B = 5.0 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.50	V dc
Base - emitter saturated voltage	3066	Test condition A; I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{BE(sat)1}$	0.60	0.90	V dc
Base - emitter saturated voltage	3066	Test condition A; I_C = 50 mA dc; I_B = 5.0 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.20	V dc
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector - emitter cutoff current	3041	Bias condition A; V_{CE} = 40 V dc; V_{BE} = 3.0 V dc	I_{CEX2}		20	µA dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 1.0 mA dc	h_{FE5}			
2N3250A				20		
2N3251A				40		
Subgroup 4						
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 10 V dc; I_C = 1 mA dc; f = 1 kHz	h_{fe}			
2N3250A				50	200	
2N3251A				100	400	
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 20 V dc; I_C = 10 mA dc; f = 100 MHz	$\lvert h_{fe} \rvert$			
2N3250A				2.5	9.0	
2N3251A				3.0	9.0	
Open circuit output capacitance	3236	V_{CB} = 100 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		6	pF

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued.						
Input capacitance (output open-circuited)	3240	V_{EB} = 1.0 V dc; I_C = 0; 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		8	pF
Collector - base time constant		V_{CE} = 20 V dc; I_C = 10 mA dc; f = 31.8 MHz; (see 4.5.2 and figure 3)	$r_b'C_c$	5	250	ps
Noise figure	3246	V_{CE} = 5.0 V dc; I_C = 10 µA dc; R_g = 1 kΩ; f = 100 Hz	NF		6	dB
Pulse response:						
Delay time	3251	Test condition A; V_{BE} = 0.5 V dc; I_C = 10 mA dc; I_{B1} = 1.0 mA dc; (see figure 1)	t_d		35	ns
Rise time	3251	Test condition A; V_{BE} = 0.5 V dc; I_C = 10 mA dc; I_{B1} = 1.0 mA dc; (see figure 1)	t_r		35	ns
Storage time	3251	Test condition A; I_C = 10 mA dc; I_{B1} = I_{B2} = 1.0 mA dc; (see figure 2)	t_s			
2N3250A					175	ns
2N3251A					200	ns
Fall time	3251	Test condition A; I_C = 10 mA dc; I_{B1} = I_{B2} = 1.0 mA dc; (see figure 2)	t_f		50	ns
Small-signal open circuit reverse-voltage transfer ratio	3211	V_{CE} = 10 V dc; I_C = 1.0 mA dc	h_{re}			
2N3250A					10	x 10^{-4}
2N3251A					20	x 10^{-4}

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued.						
Small-signal short circuit input impedance	3201	V_{CE} = 10 V dc; I_C = 1.0 mA dc; f = 1 kHz	hie			
2N3250A				1	6	kΩ
2N3251A				2	12	kΩ
Small-signal open circuit output admittance	3216	V_{CE} = 10 V dc; I_C = 1.0 mA dc f = 1 kHz	hoe			
2N3250A				4	40	μmhos
2N3251A				10	60	μmhos

1/ For sampling plan, see MIL-S-19500.

TABLE II. Groups B and C electrical-measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector - base cutoff current	3036	Bias condition D; V_{CB} = 40 V dc	I_{CBO}		20	nA dc
2.	Collector - base cutoff current	3036	Bias condition D; V_{CB} = 40 V dc	I_{CBO}		40	nA dc
3.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE3}			
	2N3250A				50	150	
	2N3251A				100	300	
4.	Collector - emitter voltage (saturated)	3071	I_C = 50 mA dc; I_B = 5.0 mA dc	$V_{CE(sat)2}$		0.5	V dc
5.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	Δh_{FE3}	±25 percent change from initial value.		
6.	Collector - base cutoff current	3036	Bias condition D; V_{CB} = 40 V dc	ΔI_{CBO}	100 percent of initial value or 5 nA dc, whichever is greater.		
7.	Collector - emitter voltage (saturated)	3071	I_C = 50 mA dc; I_B = 5.0 mA dc	$\Delta V_{CE(sat)2}$	50 mV dc change from initial value.		

1/ The electrical measurements for table IVa (JANS) of MIL-S-19500 are as follows:

a. Subgroup 3, see table II herein, steps 1, 3, and 4.

b. Subgroup 4, see table II herein, steps 1, 3, 4, and 7.

c. Subgroup 5, see table II herein, steps 1, 3, 4, 5, 6, and 7.

2/ The electrical measurements for table IVb (JANTX and JANTXV) of MIL-S-19500 are as follows:

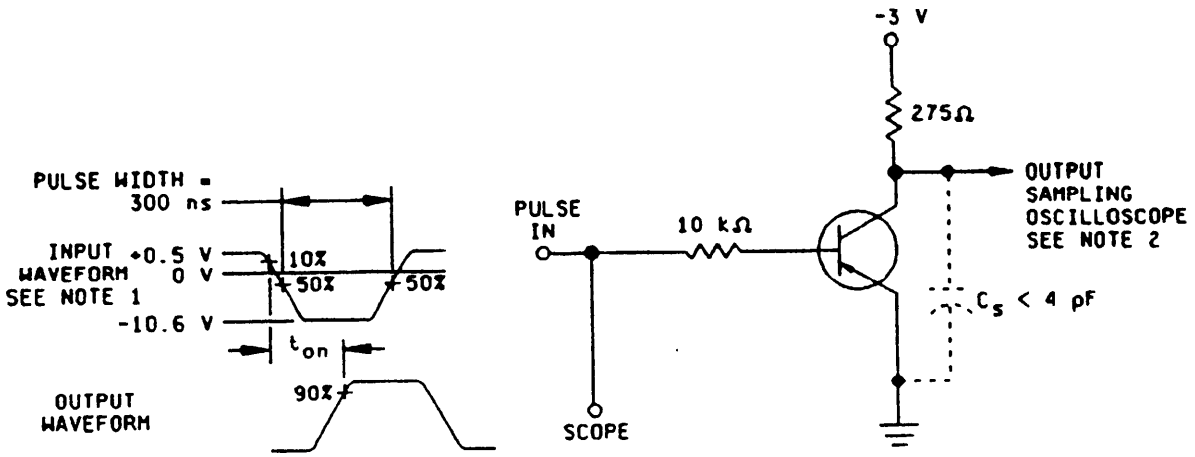
a. Subgroup 2, see table II herein, steps 1 and 3.

b. Subgroups 3 and 6, see table II herein, steps 2 and 5.

3/ The electrical measurements for table V of MIL-S-19500 are as follows:

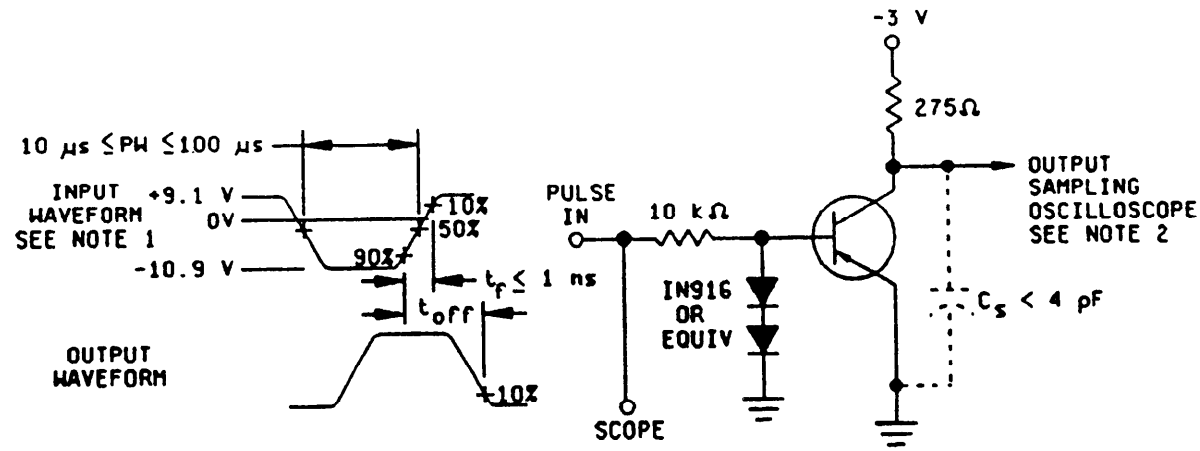
a. Subgroups 2 and 3, table II herein, steps 1, 3, and 4.

b. Subgroup 6, see table II herein, steps 1, 3, 4, 5, and 6 (for JANS) and 2, 3, and 5 (for JAN, JANTX, and JANTXV).



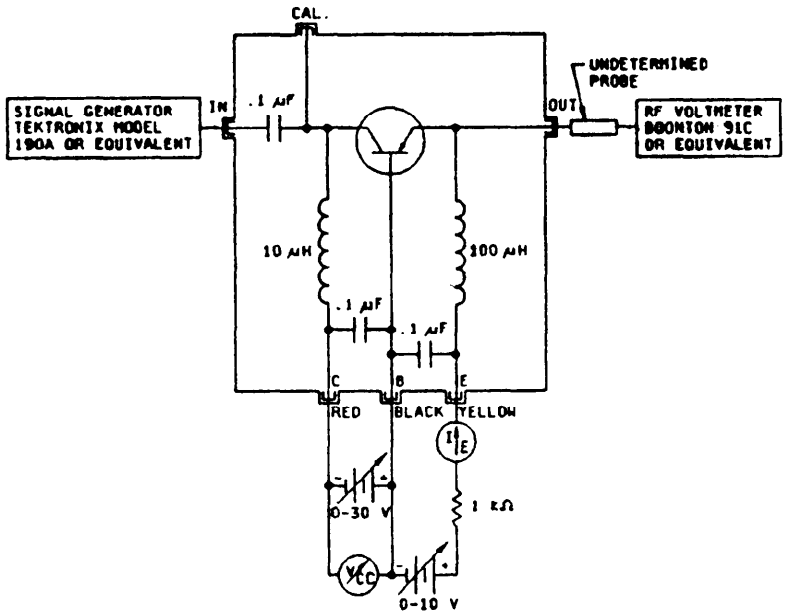
NOTES:
1. The rise time (t_r) of the applied pulse shall be ≤ 1.0 ns, duty cycle ≤ 2 percent, and the generator source Z shall be 50Ω.
2. Sampling oscilloscope: Z_{IN} ≥ 100 kΩ; rise time (t_r) ≤ .1 ns.

FIGURE 1. Delay and rise time, test circuit.



NOTES:
1. The rise time (t_r) of the applied pulse shall be ≤ 1.0 ns, duty cycle ≤ 2 percent, and the generator source Z shall be 50Ω.
2. Sampling oscilloscope: Z_{IN} ≥ 100 kΩ; rise time (t_r) ≤ .1 ns.

FIGURE 2. Storage and fall time, test circuit.



Procedure:

1. Set signal generator to 31.8 MHz and connect to "IN" connector on test jig.
2. Connect low voltage dc power supplies as shown. A 1 KΩ resistor should be placed in series with the emitter power supply to prevent damage to transistors being tested.
3. Set collector supply for V_{CE} = -20 V dc, and emitter supply for I_C = -10 mA.
4. Connect RF voltmeter with unterminated probe adapter to "CAL" connector on test jig. Adjust signal generator until RF voltage is 1 volt (NOTE: Decade switching of voltmeter should be accurate from 1 mV to 3 volts. If not, input voltage may be set using voltage dividers, utilizing lower scales of the RF voltmeter. If this is done, the voltage dividers should be left in place when the voltmeter is removed, as they constitute a load on the input of the circuit.)
5. Remove RF voltmeter from "CAL" connector and connect to "OUT" connector. Meter will now read $r_b'C_c$ as follows:

Meter range full scale	$r_b'C_c$ range
.003 volts	10 to 30 ps
.01 volts	30 to 100 ps
.03 volts	100 to 300 ps
.1 volt	150 to 500 ps

FIGURE 3. Collector-base time constant test circuit (an equivalent circuit may be used).

4.5.3 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3131 of MIL-STD-750. The following details shall apply:

a. Minimum collector magnitude shall be 36 mA dc.

b. Collector to emitter voltage magnitude shall be 10 V dc.

c. Reference point temperature shall be +25°C ≤ T_R ≤ +35°C. The chosen reference temperature shall be recorded before the test is started.

d. Maximum $R_{\theta JA}$ limit shall be 485.4°C/W.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.1).

b. Lead finish as specified (see 3.3.1).

c. Type designation and product assurance level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Army - AR, AV, MI, SM
Navy - AS, CG, MC
Air Force - 13, 19, 85, 99
DLA - ES

Preparing activity:
Navy - EC

Agent:
DLA - ES

(Project 5961-1447)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-S-19500/323D	2. DOCUMENT DATE (YYMMDD) 93/09/15

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING, TYPE 2N3250A, 2N3251A, JANTX, JANTXV, AND JANS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Alan Barone	b. TELEPHONE (Include Area Code) (1) Commercial: 513-296-6048 (2) AUTOVON: 986-6048
c. ADDRESS (Include Zip Code) DESC-ECT Dayton, OH 45444-5270	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340